Health Consultation

DDT IN NATIONAL PARK SERVICE BUILDINGS AT BIG SPRING
WITHIN OZARK NATIONAL SCENIC RIVERWAYS NATIONAL PARK AREA

CARTER COUNTY NEAR VAN BUREN, MISSOURI

FEBRUARY 9, 2015

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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Prepared By:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry (ATSDR)
Division of Community Health Investigations

Background Introduction

In August 2014, the Agency for Toxic Substances and Disease Registry (ATSDR) prepared a health consultation in response to a request made by the U.S. National Park Service (NPS) to evaluate pesticide levels in the indoor air of several park buildings within Ozark National Scenic Riverways (ONSR), National Park area 30 years after application.

The health consultation provided exposure estimates to airborne pesticides and identified buildings in the ONSR park where pesticide exposure could be reduced. The health consultation identified the potential for the presence of DDT on indoor surfaces in some rental cabins and recommended surface-wipe sampling for confirmation. This health consultation addresses the results of the recommended DDT surface-wipe sampling.

Conclusion 1

ATSDR concludes that exposure to the levels of DDT found on the floor of Building 408 could increase the risk of harmful health effects in very young children. Older children and adults are not likely to be impacted.

Basis for Conclusion

ATSDR estimates that very young children (6 months to 6 years of age) who play on the floor might unintentionally ingest, through typical hand-to-mouth activity, enough DDT to be a health concern and thus warrant measures to prevent this exposure. Although exposure to these levels has not been shown to cause adverse effects in humans, specific adverse health effects in animal studies at doses 1000 times greater than at this site include hyperactivity and liver changes.

Next Steps

ATSDR recommends that NPS reduce children's potential DDT exposure in Building 408.

Conclusion 2

ATSDR concludes that the levels of DDT found on the floor of Buildings 401, 407, 409, and 411 are not likely to be hazardous to very young children under the current short-term use of the buildings. However, should these buildings be used for longer periods (estimated to be more than 12 months), children might have increased DDT exposure above a level of concern. Older children and adults are not likely to be impacted.

Basis for Conclusion

Levels of DDT detected in Buildings 401, 407, 409, and 411 are below levels of health concern for short-term (estimated to be less than 12 months) exposures. Exposures of longer duration may necessitate exposure-reduction measures.

Next Steps

ATSDR recommends ensuring that cleaning materials, solutions, and processes are not contributing to the amount DDT found on the floors by spreading DDT from area to area or cabin to cabin. It is possible that DDT is inadvertently being spread during cleaning.

ATSDR will remain available to provide technical assistance to the NPS while they undertake administrative and engineering measures.

Site Description and History

Big Spring was one of Missouri's first state parks beginning in 1924 until 1969 when it was donated, along with Alley and Round Spring State Parks to the National Park Service to become a part of the Ozark National Scenic Riverways. The Ozark National Scenic Riverways (ONSR), National Park was established in 1964 as the first national park area to protect a wild river system [NPS 2013]. Prior to the ONSR becoming a national park, it was Missouri State public land. ONSR includes many areas along two river systems: Jacks Fork River and Current River. ONSR stretches across 80,000 acres in Shannon, Carter, Dent, and Texas counties near the towns of Van Buren and Eminence in southern Missouri. ONSR areas are managed by the National Park Service (NPS). Adjacent to areas of the ONSR are Ozark National Forest managed by the U.S. Forest Service and state owned "Missouri Natural Areas" managed by the Missouri Department of Conservation [Price No Date].

The ONSR area includes the cold spring-fed Jacks Fork River and the Current River, hundreds of freshwater springs, caves, trails, and historic sites. Within the ONSR, the NPS maintains over 100 buildings including NPS employee offices and residences, rental cabins, visitors centers, dining facilities, and picnic shelters [NPS 2013].

During the Great Depression from 1933 to 1942, President Franklin D. Roosevelt created the Civilian Conservation Corps (CCC), a country-wide public work relief program as part of the New Deal to get unemployed men back to work. The NPS managed the program and in 1933, established camps at Big Spring Park and Alley Spring Park state parks (now within the ONSR) [CCC Legacy 2014].

CCC workers at Big Spring established much of the park's infrastructure. They built roads, trails, and fitted pumps in the springs to provide the camp and the public campgrounds with water. They hung telephone lines, removed debris, and cleared land for campgrounds and picnic areas. They also built 14 cabins in Big Spring, a custodian's home and Big Spring Dining Lodge. The cabins are on the National Register of Historical Places [Big Spring Park 2014]. They were made with local materials, such as rough-cut limestone quarried nearby and timber and lumber stained dark brown. They demonstrate the rustic style of architecture popularized by the National Park Service [Griffin 2014]. The cabins are rented typically by the week although shorter or slightly longer rentals may be available. The cabins were removed from the rental program after the 2014 season pending remodeling [Big Spring Park 2014].

Photo: Cabin 408, Lynn Parman, Tetra Tech 2013

Photo: Cabin 408
http://bigspringlodgeandcabins.com/726653.html

Pesticide Application

It is not known when DDT was applied to the cabins. DDT and its degradation products (DDD and DDE) can persist an especially long time if on a hard surface and out of direct sunlight. It is also possible that application of the pesticide dicofol, which is structurally very similar to DDT, could have been the source of the DDT detected in August 2014. Dicolfol was contaminated with DDT in many formulations up until 1986 [Extoxnet 1993]. Historically, DDT was often applied to control mosquitoes, moths, roaches, and other non-structure destroying pests; and was possibly applied many times over the years, as it was widely used as a general use insecticide. Dicofol was used for landscape pest control, among other uses. While there is no record of DDT or dicofol application, it is known that in October 1982, 58 buildings in the areas of Big Spring, Alley Spring, Powder Mill, and Round Spring were treated for termites with a pesticide containing chlordane.

Previous Investigations

In July 2013, NPS requested that ATSDR evaluate pesticide levels in the indoor air of several park buildings within Ozark National Scenic Riverways (ONSR), National Park area 30 years after the pesticides had been applied. Tetra Tech collected air samples at selected prioritized buildings to serve as the basis for the health consultation [Tetra Tech 2013a, 2013b, 2013c].

ATSDR reviewed the data, provided exposure estimates to airborne pesticides, and identified buildings in the ONSR that could be made safer by taking measures to reduce pesticide levels and migration of indoor air levels. ATSDR noted from the data that, although the levels of chlordane in indoor air of the Big Spring Cabins Buildings 401 through 414 were quite low (not at levels of health concern) unexpected trace levels of DDT were detected in indoor air in several Big Spring cabins. ATSDR recommended that follow-up surface wipe samples be collected from the cabins where DDT was detected in air.

Methods and Results

Sampling

Wipe samples were collected from the floors of buildings that had detectable levels of DDT in indoor air. A single sterile gauze pad was used for each floor sample. The sterile gauze pads were moistened with 2 ml of hexane from a premeasured ampule; then a square area of 10 cm x 10 cm was wiped thoroughly with light pressure, in one direction and then perpendicular to that direction. The gauze was then folded with the sample side down into an amber collection vial. Vials were sent to the State Hygienic Laboratory at the University of Iowa where the samples were prepared by solvent extraction using EPA's method 3580 and then analyzed using EPA's method #8081 (Chlorinated Hydrocarbon Insecticides).

Sampling Results

DDT and its degradation products (DDD and DDE) were detected in Buildings 408, 411, 409, 407, and 401. Table 1 provides the wipe sampling results along with the previous air sampling results. The building with the highest levels of DDT in indoor air did not correspond with the highest levels of DDT on the surface wipes (discussed later). Building 408 had levels of DDT more than 10-times higher than the next highest levels in Building 411.

Table 1. Summary Results of DDT Sampling

Building Number	DDT in Air ($\mu g/m^3$)	DDT* Surface Wipe	DDE* Surface Wipe	DDD* Surface Wipe
408 LR	0.0075	5	0.7	0.6
408 BR	NS	3	0.3	0.3
411 BR	NS	0.4	ND	ND
411 LR	0.0093	0.2	ND	ND
409 LR	0.0094	0.3	ND	ND
409 BR	NS	ND	ND	ND
407 LR	0.0084	0.2	ND	ND
407 BR	NS	0.2	ND	ND
401 BR	NS	0.2	0.2	ND
401 LR	0.014	ND	ND	ND
412 LR	0.0083	ND	ND	ND
412 BR	NS	ND	ND	ND

* Concentration in ($\mu g/100\ cm^2$) Detected values are shaded
ND = analyte was not detected at or above 0.1 $\mu g/100\ cm^2$
NS = room was not sampled
Bldg 401 also detected DDE a breakdown product of DDT at 0.0089 $\mu g/m^3$ in indoor air.
BR = Bedroom LR = Living room

Discussion

Public Health Implications

DDT[1]

DDT (1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane) is a pesticide that was once widely used to control insects on agricultural crops, in residential neighborhoods and even as a delousing powder directly used on people. It was invented in 1939 and was widely used in World War II to control insects (mosquitoes) that carry diseases such as malaria and typhus. Today, only a few countries use DDT to control malaria. Both DDE and DDD are breakdown products of DDT. DDD was used medically to treat cancer of the adrenal gland. After 1972, the use of DDT was no longer permitted in the United States except in cases of a public health emergency. The use of the structurally-similar pesticide dicofol that could contain varying levels of DDT continued until at least 1986 (Extoxnet, 1993). Newer dicofol formulations were required to contain less than 0.1% DDT.

Despite the long time and widespread exposure of millions of people to DDT, studies of the health effects of low dose exposures do not show adverse health effects. Possible reasons for the lack of adverse effects could be that the effects of DDT exposures are common to other diseases or conditions and are masked or not thought to be related to DDT exposure. Another possible reason for the lack of adverse effect evidence may be that despite widespread use and exposure, the amount of the substances taken in by the body does not demonstrate an apparent effect on the adult human body at low doses [Hayes 1971]. Exposure doses (1000 times greater than here) have been shown to produce effects that are not apparent at low doses. These effects included liver and neurologic effects which were the effects observed in animals discussed below.

From Animal Studies

ATSDR has published a Toxicological Profile on DDT, which identifies several available animal studies and some, but insufficient human studies. In the DDT profile, ATSDR identifies a lowest-observed-adverse effect level (LOAEL) of 0.5 mg/kg/day (500 µg/kg/day) for neurodevelopmental effects in mice reported in a series of studies from the same group of investigators [Eriksson and Nordberg 1986; Eriksson et al. 1990a, 1990b, 1992, 1993; Johansson et al. 1995, 1996; Talts et al. 1998].

The most significant finding in that study was the presence of altered motor behavior in adult mice treated with DDT perinatally. Exposure at 10 days old appeared to be a critical window for maximum effects. During the last 40 minutes of behavioral testing, the treated mice showed significantly more activity than untreated controls. The DDT-induced increase in spontaneous motor activity (hyperactivity) at the dose of 0.5 mg/kg (500 µg/kg) is considered a less serious LOAEL. "Less serious" effects are those that are not expected to cause significant dysfunction or death, or those whose significance to the organism is not entirely clear [ATSDR 2002]. The physiological basis for this behavioral effect was confirmed by neurochemical evaluation, which found decreased density of muscarinic acetylcholine in the cerebral cortex.

[1] DDT is not the same as DEET, N,N-Diethyl-meta-toluamide, a currently used insect repellent.

ATSDR identified a no-observed-adverse-effect level (NOAEL) of 0.05–0.09 mg/kg/day (Laug et al. 1950). This study identified liver effects in Osborne-Mendel rats administered technical DDT in the diet at dosage levels of 0, 1, 5, 10, or 50 ppm for 15–27 weeks . The approximate doses provided in the diet in this study were 0.05–0.09, 0.25–0.5, 0.5–0.9, and 2.5–4.6 mg/kg/day. There were no morphologic alterations in the kidneys. Liver alterations were noticed at the 5 ppm (0.25–0.5 mg/kg/day) dietary level of DDT and higher, but not at 1 ppm (0.05–0.09 mg/kg/day). Liver changes consisted of hepatic cell enlargement. Necrosis was not observed. Changes seen at the 5 ppm level (0.25–05 mg/kg/day) were considered by the authors as "minimal".

In the Fitzhugh and Nelson (1947) study, 16 female Osborne-Mendel rats were fed a diet containing 1,000 ppm technical DDT (approximately 96 mg/kg/day) for 12 weeks. Minimal liver changes were apparent after 4–6 weeks of recovery, and complete recovery was seen after 8 weeks.

Our Evaluation of NPS DDT

The 2013 Air Samples

DDT was previously detected in indoor air of six (Buildings 401, 407, 408, 409, 411, and 412) of 45 buildings; all of them are short-term rental cabins. Levels of DDT in air ranged from 0.0075 to 0.014 $\mu g/m^3$. (See Table 1)

The 2014 Wipe Samples

DDT was detected in surface wipe samples in five of six buildings where detectable levels of DDT were found in indoor air. Building 408 has the highest wipe sample levels--10 times greater than in any other building. There was no relationship between the amount of DDT detected on the floor and the amount measured in the air. One possible explanation for the collective results is that the cleaning service is spreading the DDT from one cabin to the next when mopping the floors because it was unexpected to find DDT on the linoleum floor in Building 401. DDT detected in other buildings was on the wood floors; these floors are as old as the buildings and could have historic accumulation of DDT on the surface and in pore spaces. It is also possible that mops used on the floors were contaminated with DDT from somewhere off-site.

What is known about the toxicity of DDT at levels found in the buildings?

Children are at a greater risk of adverse health effects from DDT exposure than adults in general because they spend more time near the areas that were likely sprayed, such as floor boards. Children have near-continuous hand-to-mouth activity likely resulting in greater contact and ingestion of pesticide residues.

ATSDR can estimate a child's dose to the DDT found in Building 408 and then compare that dose to animal study doses. A 10 kg (22-pound) child (age 0-12 months, most conservative approach) could reach the acute MRL dose if he/she were to ingest all the DDT found on the living room wipe sample.[2] Older children and adults are not likely to ingest as much. Because there are no comparable children studies with DDT, there is a great deal of uncertainty in the validity of applying numerical calculations to health or risk assessments. For that reason, risk characterization for NPS buildings is limited and should not be used to predict health outcomes. Instead, ATSDR emphasizes that measures focus on preventing, reducing, or eliminating the risk. Prudent public health practice dictates reducing pesticide exposure wherever possible, especially in living spaces. Measures to reduce indoor exposure to contaminants in buildings or to reduce human contact will reduce health risk.

Exposure, Fate, and Transport of DDT

Previous investigations identified DDT in the air of some of the park buildings. Most of these buildings have wooden floors. DDT was likely applied to the surfaces. Since DDT does not easily become a vapor and is relatively insoluble, it remains for decades on some surfaces [ATSDR 2002, Clark 2002, Hosenfeld 1986]. Contact with DDT can be prevented with the use of barriers, but the choice of barriers needs to consider the properties of DDT which govern its fate and transport. However, because DDT can be repelled by water, mopping surfaces might spread it to other surfaces or onto the fibers of the mop. Exposures should be reduced by placing barriers between the treated wood and children.

Other pathways to pesticides at NPS buildings

Several pesticides were found in the living space air samples of ONSR NPS buildings at moderately low levels (levels not expected to harm people's health). These chemicals were applied more than 30 years ago, yet traces are still present. Each individually presents a low risk. The combined risk cannot be adequately addressed by using conventional additive methods. Although combined risks for some effects have been studied for aldrin, heptachlor, and chlordane, combined risks of exposure are not fully understood [ATSDR 1994, ATSDR 2013]. The presence of these pesticides, in addition to the DDT in the air of some buildings as well as on floor surfaces, adds an additional degree of uncertainty and a need for precaution.

2 The 408 living room sample contained 5 µg DDT; thus a 10 kg child would obtain a 0.5 µg/kg/day dose should the entire contents be ingested. This estimated dose is 1000 times less than the LOAEL dose of 0.5 mg/kg/d (500 µg /kg/d) shown to produce an adverse effect in animals and is equivalent to ATSDR's minimal risk level 0.5 µg/kg/day, an estimate of the daily human exposure to a substance that is likely to be without appreciable risk of adverse health effects.

Limitations

In the absence of a definitive conclusion about the extent of the hazard presented by site conditions, this document focuses on reducing the current levels of DDT on the floors of NPS buildings. This evaluation contains several limitations and uncertainties in characterizing the hazard risk because of the limited amount of toxicological information regarding the human health effects of the detected pesticides at levels similar to those found in NPS buildings. To address this uncertainty, ATSDR uses a conservative (i.e., protective) approach that is consistent with the public health principle of prevention and believes the focus should be placed on ways to prevent, reduce, or eliminate exposure.

Although ATSDR recognizes the utility of numerical evaluations, the agency considers such estimates in the context of the variables and assumptions involved in their derivation and in the broader context of biomedical opinion, human factors, and actual exposure conditions. The actual parameters of environmental exposures must be given careful consideration in evaluating the assumptions and variables relating to both toxicity and exposure [ATSDR 1993]. For that reason, risk characterization for NPS buildings is limited and should not be used to predict health outcomes. Instead, ATSDR emphasizes the measures needed to prevent, reduce, or eliminate the risk.

Children's Health Considerations

Pesticides are typically applied to areas low to the ground where children play and where dust collects. It is prudent to keep children away from areas where they can come in direct contact with pesticide dusts. Children can put objects that have pesticide residues in their mouths, and generally put their hands in their mouths and touch their faces more often than adults. They also breathe a greater volume of air per body weight than adults. Thus, the behavior and physical characteristics of children can lead to higher pesticide exposures than adults.
https://michigan.gov/documents/ATSDRChildrensHealthhandoutsFS_155917_7.pdf

Conclusions

1. ATSDR concludes that exposure to the levels of DDT found on the floor of Building 408 could increase the risk of harmful health effects in very young children (6 months to 6 years). Older children and adults are not likely impacted.

2. ATSDR concludes that the levels DDT found on the floor Buildings 401, 407, 409, and 411 are not likely to be hazardous to very young children, older children, or adults under the current use of the buildings. However, should these short-term rental buildings be used for longer periods, children may have an increased DDT exposure.

Recommendations

1. ATSDR recommends that NPS reduce children's potential DDT exposure in Building 408 even though the levels of pesticides present indoors have not been shown to cause adverse health effects in adults, children, and unborn children. Some suggested ways to reduce exposure to pesticides on floors include:

    • Placing a barrier or floor covering on areas of frequent contact.
    • Limiting occupancy time or consider alternative uses.

2. ATSDR recommends that NPS ensure that cleaning materials, solutions, and processes are not spreading or contributing to the amount DDT found on the floors.

3. ATSDR recommends confirmation sampling be completed after measures are taken to reduce exposure.

Public Health Action Plan

Completed Actions:

1. Upon receipt of the 2014 wipe samples (September 5, 2014), ATSDR contacted the NPS with precautionary recommendations for Building 408.

2. NPS promptly discontinued use of Building 408.

3. ATSDR met with NPS employees to discuss the findings of the air and surface wipe evaluations and answer health questions.

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